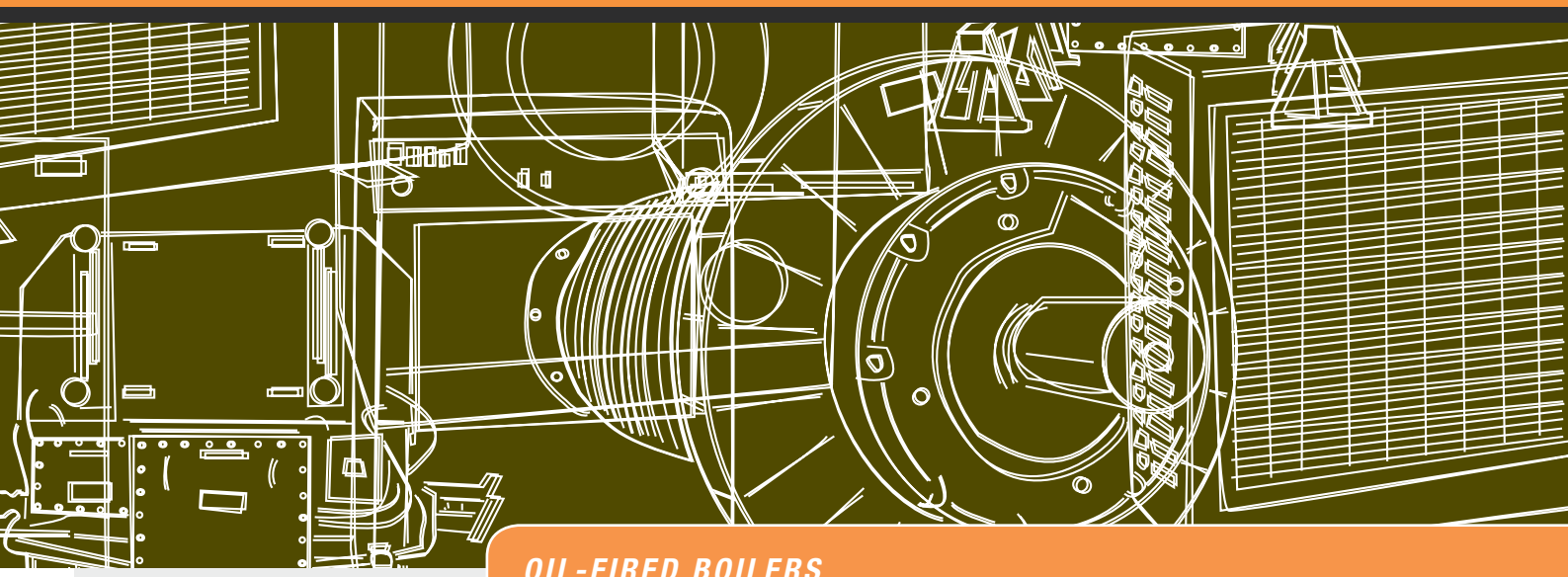
Report No: 2004/09

NATIONAL APPLIANCE AND EQUIPMENT ENERGY EFFICIENCY PROGRAM

# No Action Proposal



## *OIL-FIRED BOILERS*

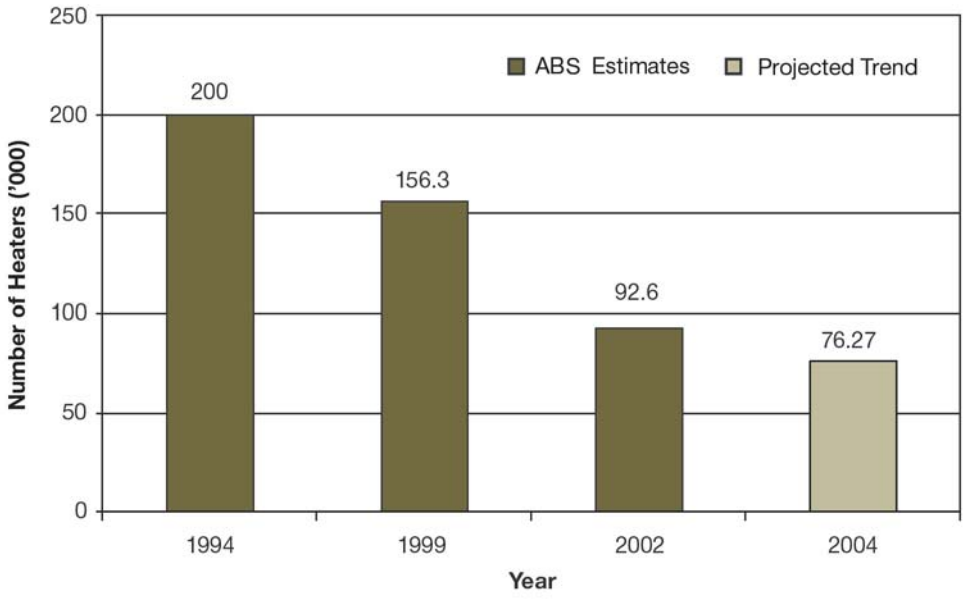
PREPARED FOR

THE AUSTRALIAN GREENHOUSE OFFICE UNDER
THE NATIONAL APPLIANCE & EQUIPMENT ENERGY
EFFICIENCY PROGRAM

# No Action Proposal - Oil-Fired Burners

Oil-fired boilers and water heaters occupy a relatively small market in Australia. Industry and Australian Bureau of Statistics sources suggest that both domestic and commercial/industrial oil-fired boiler installations appear to be in rapid decline though data specifically targeting oil-fired boilers in Australia is limited. Data available in 2001 relating to domestic boilers, used almost exclusively for central space heating applications, shows the installed stock for all fuel types to be only 90,000 units[1] compared with around 7.5 million units of all types of domestic water heating systems. More recent ABS estimates show the number of domestic oil-based space heating systems dropped from 200,000 units in 1994 to less than 93,000 units in 2002, a decline of nearly 54% in 8 years, reflected in Figure 1.

**FIGURE 1: NUMBER OF INSTALLED OIL-FIRED DOMESTIC SPACE HEATING SYSTEMS 1994-2002**




1 Analysis of Potential for Minimum Energy Performance Standards for Packaged Boilers, Final Report, Prepared for the Australian Greenhouse Office by Mark Ellis & Associates, March 1st, 2001

## STAKEHOLDER COMMENT

*NAEEEC invites comments from any interested person or organisation on the measures proposed in this study. Comments should be directed to energy.rating@greenhouse.gov.au by 31 December 2004. Information sessions for industry participants can be arranged during the comment period if requested.*

*Electronic copies of profiles and full reports released for public discussion can be obtained from www.energyrating.gov.au*

**FIGURE 2: NUMBER OF INSTALLED OIL-FIRED DOMESTIC WATER HEATING SYSTEMS 1999-2002**

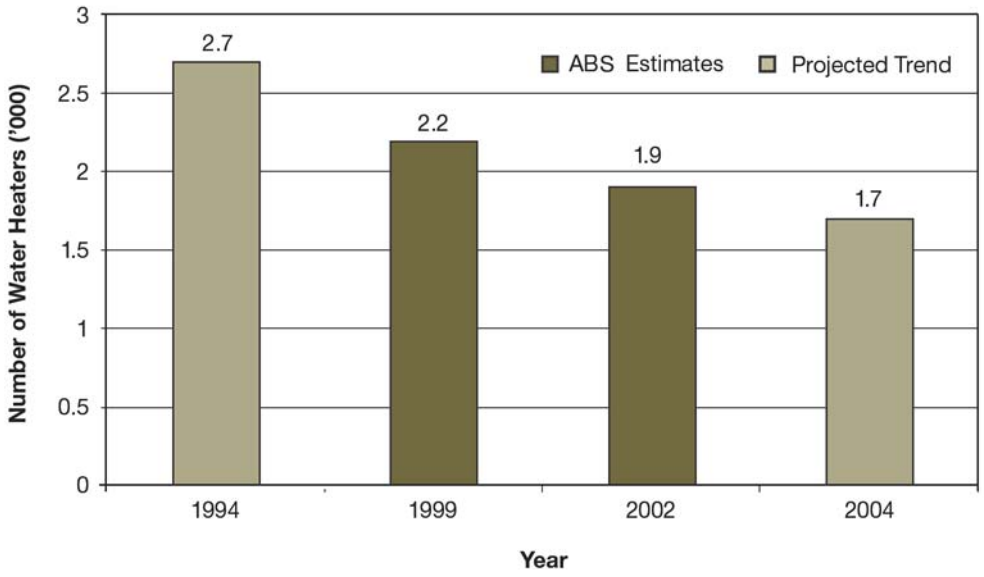
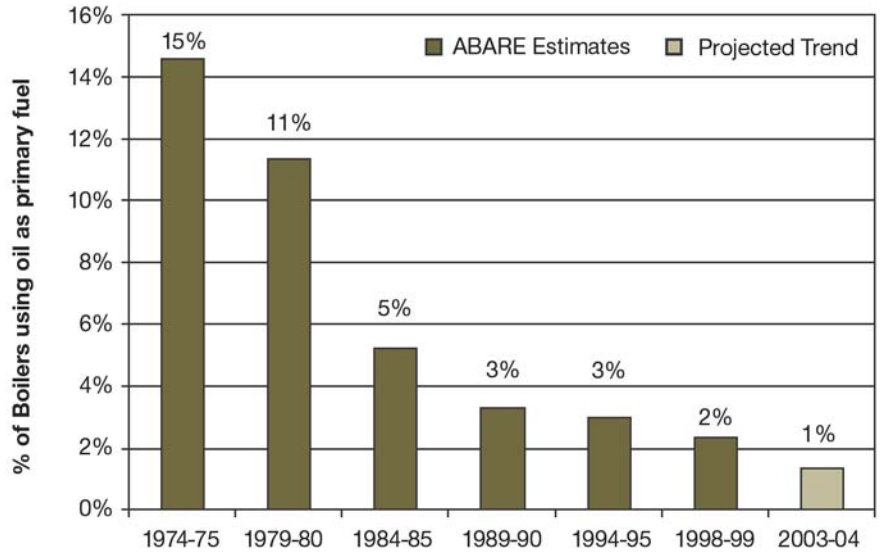



**FIGURE 3: PERCENTAGE OF COMMERCIAL BOILERS USING OIL AS PRIMARY FUEL 1974-2004**




Similarly, Figure 2 demonstrates that the number of oil-based water heating systems has dropped from 2,200 units in 1999 to 1,900 units in 2002, a decline of about 14% in 3 years. (These figures may include oil fuelled products other than boilers.) Based on such data, the present stock shares of oil-fired space and water heating systems are estimated to be around 1.5% and 0.02% respectively. These numbers appear to be consistent with those of leading manufacturers and distributors who estimate oil-fired boilers represent around 1% of the market.

Sources believe that the number of commercial-scale oil-fired boilers and water heating systems is declining so rapidly that it will be an insignificant factor in the total boiler and water heater market within a few years. ABARE data indicates that the use of all fuel types which fall within the broader category of "oil" have consistently declined over the period between 1974 and 1999. Figure 3 demonstrates the share of oil as a primary fuel for boilers was around 15% in 1974-75, and declined to a meager 2.5% in 1998-99. The projected trend

estimates suggest that the share of oil as primary boiler fuel will decline to around 1% in the year 2004.

Industry sources also suggest that the market for new oil-fired boilers and water heating systems is declining rapidly. Only a limited number of units are manufactured each year to serve a very small intermittent market and firms reported conversion of oil-fired boilers to gas-fired systems has increased during the last few years. The remote areas of Queensland and Northern Territory appear to be the major users of oil-fired boilers with the appliance making up an estimated 25% - 30% of the industrial scale boilers market in these states.

## INTERNATIONAL HARMONISATION

Various types of boilers are subjected to performance regulation in the United Kingdom, Canada, the US and Chinese Taipei. Oil-fired boilers and water heaters are specifically covered by MEPS in three APEC countries, USA, Canada and Chinese Taipei. Japan will introduce target standards specifically aimed at oil-fired burners in 2006. In 1992-93 the EU introduced the European Directive on Boiler Efficiency. This directive sets out standards for minimum energy efficiency values for all types of boilers including oil-fired, however only the UK has enforced this directive in 1994 with failure to comply resulting in fines of up to £5000. In addition, a joint UK government and manufacturer initiative maintains a database of average operating efficiencies of all types of boilers manufactured and imported in the country. It is worth noting that the efficiency of a boiler is generally associated with loading conditions, and the average weather conditions in North America and Europe are significantly colder than most parts of Australia and therefore heating loads are much higher. The milder climate of Australia suggests that this product is unlikely to become price competitive with boilers utilising other fuels.

There is no clear major supplier of product nor strong link to specific country-of-origin of imported equipment that would make following the lead of one country most appropriate for this product type. It seems the supply of these products is drawn from throughout the world.

While Australia could undertake a comparison study of these various levels, this additional step has not been undertaken at this time.

## IMPACT OF MEPS

In Australia oil fuels contribute only 53.4PJ out of a total energy input of 2,252PJ for boilers in commercial and industrial uses during the year 1998-99. This amounted to just 2.4% of the total boiler input energy in that year. At present the oil fuels are estimated to contribute only around 1% of the total fuel input to the industrial/commercial scale boilers.

Given the relatively small impact and the declining market, any reduction in energy or greenhouse gas that could be achieved by regulation is likely to be too small to offset the costs of introduction of regulation.

## NAEEEC PROPOSAL

NAEEEC proposes not to further consider including this product type in the program because of a number of related factors:

- the rapidly diminishing market of oil-fired boilers and water heating systems in Australia
- the relatively minor contribution to total energy use by oil-fired boilers
- the range efficiency levels of new oil-fired boiler is likely to be small
- the very marginal impact resulting from implementation of a suitable MEPS

## NAEEEC MEMBERS

The Commonwealth, New Zealand, and all State and Territory governments are part of NAEEEC. Representatives are senior officials from various government agencies and statutory authorities or persons appointed to represent those bodies.

The *Australian Greenhouse Office (AGO)* is the Australian Government agency responsible for monitoring the National Greenhouse Strategy in cooperation with State and Territory Governments and with the support of local government, industry and the community. The AGO chairs NAEEEC and other members provide support for its activities.

The NSW *Ministry of Energy and Utilities* (incorporated within the Department of Energy, Utilities and Sustainability since 1 January 2004) provides policy advice to the NSW Government and operates a regulatory framework aimed at facilitating environmentally responsible appliance and equipment energy use. The Ministry is represented on the Energy Efficiency and Greenhouse Working Group, through which the appliance and equipment related elements of the National Greenhouse Strategy are being progressed.

The NSW *Sustainable Energy Development Authority* was established in February 1996 with a mission to reduce the level of greenhouse emissions in New South Wales by investing in the commercialisation and use of sustainable energy technologies.

The *Office of the Chief Electrical Inspector* is the Victorian technical regulator responsible for electrical safety and equipment efficiency. Its mission is to ensure the safety of electricity supply and use throughout the State. The corporate vision of the Office is to demonstrate national leadership in electrical safety matters and to improve the superior electrical safety record in Victoria. The Office's strategic focus is to ensure a high level of compliance is sustained by industry with equipment efficiency labelling and associated regulations.

The *Sustainable Energy Authority* was established in 2000 by the Victorian Government to provide a focus for sustainable energy in Victoria. The Authority's objective is to accelerate progress towards a sustainable energy future by bringing together the best available knowledge and expertise to stimulate innovation and provide Victorians with greater choice in how they can take action to significantly improve energy sustainability.

The *Electrical Safety Office*, Department of Industrial Relations, is the Queensland technical regulator responsible for electrical safety and appliance and equipment energy efficiency. The office ensures compliance with electrical safety and efficiency regulations throughout Queensland.

The *Department of Energy* is the lead agency with regard to sustainable development within the Queensland energy sector and is involved in a range of activities that reflect the importance of a sustainable approach. These activities involve developing and evaluating policies and initiatives through flexible and responsible decision making that allows economic, environmental and social outcomes from the energy sector to be maximised.

The Western Australian electricity regulator *Energy Safety* (a Division of the Department of Consumer and Employment Protection) is responsible for the technical and safety regulation of the electrical industry in WA. This includes the safety of consumers' electrical installations and appliances and the auditing of appliances and equipment to check compliance with energy efficiency and prescribed safety requirements.

The Western Australian *Sustainable Energy Development Office* promotes more efficient energy use and increased use of renewable energy to help reduce greenhouse gas emissions and increase jobs in related industries.

The *Office of the Technical Regulator* seeks to ensure the coordinated development and implementation of policies and regulatory responsibilities for the safe, efficient and responsible provision and use of energy for the benefit of the South Australian community.

The Tasmanian Government's interest is managed by the Department of Infrastructure, Energy and Resources' *Office of Energy, Planning and Conservation (OEPC)*. The OEPC provides policy advice on energy related matters including energy efficiency. Its web site is www.dier.tas.gov.au/energy/indext.html.

*Electricity Standards and Safety* is the technical regulator responsible for electrical safety throughout Tasmania. Regulatory responsibilities include electrical licensing, appliance approval and equipment energy efficiency.

The Australian Capital Territory's interest is managed by the *Energy Policy Unit, Economic Management Branch*, Department of Treasury. The primary function of this Unit is to provide the ACT Government with advice on National and Territory energy related matters including energy efficiency.

The *Department of Infrastructure, Planning and Environment* is responsible for the administration of regulations in the Northern Territory regarding various aspects of safety, performance and licensing for goods and services including electrical appliances.

The *Energy Efficiency and Conservation Authority (EECA)* is the principal body responsible for delivering New Zealand's National Energy Efficiency and Conservation Strategy (NEECS). EECA's function is to encourage, promote and support energy efficiency, energy conservation and the use of renewable energy sources.



*Analysis of the Potential Policy Option:*

# *Heating and Cooling Equipment – Oil-fired Boilers and Water Heating Systems*

*Prepared for*

*The Australian Greenhouse Office: National Appliance & Equipment Energy Efficiency Program*

October 2004

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# Introduction

The purpose of this report is to provide an analysis of the policy options, primarily their suitability for Minimum Energy Efficiency Standards (MEPS), for the new product types identified in the National Appliance & Equipment Energy Efficiency Program for calendar year 2003. This report covers oil-fired boiler and water heating systems. The primary purpose of this analysis is to investigate this product type for suitability to MEPS.

## Background of Boiler Efficiency Regulation

The National Appliance and Equipment Energy Efficiency Program (NAEEEP) is part of the National Greenhouse Strategy that targets the energy efficiency of consumer appliances and, industrial and commercial equipment. The main tools of the Program are mandatory energy efficiency labelling and minimum energy performance standards, and voluntary measures including endorsement labelling, training and support to promote the best available products. Mandatory minimum energy efficiency performance standards (MEPS) are needed to overcome the market failure regarding whole-of-life costs and to meet the objectives of both increasing energy efficiency and reducing greenhouse gas emissions.

National product regulation can only be justified where the benefits outweigh the costs to the community; and the cost of improving appliance efficiency is outweighed by the energy savings made over the lifetime of the product.

Packaged Gas Boilers were examined and rejected for MEPS in a previous NAEEEP study in 2001[1].

## Scope

This report covers all types and sizes of domestic and commercial/industrial boilers and water heating systems that use liquid petroleum fuels that are stable at normal temperature and pressure, such as; crude oil and condensate used directly as fuel, refined products used as fuels (aviation gasoline, automotive gasoline, power kerosene, aviation turbine fuel, lighting kerosene, heating oil, automotive diesel oil, industrial diesel fuel, fuel oil, refinery fuel and naphtha) as primary fuel. This report does not cover boilers and water heaters that use natural gas, LPG or other types of fuel that can not be categorized as "oil" fuels, as primary fuel. This report also excludes dual fuel boilers and water heating systems that use oil as reserve fuel option for the event when supply of primary fuel (e.g. natural gas, electricity) is lost.

[1] Analysis of Potential for Minimum Energy Performance Standards for Packaged Boilers. Mark Ellis and Associates, 2001 for AGO

# Product Description

## Boilers and Water Heating Systems

Boilers and/or water heating systems are designed to use the energy in input fuel to raise the energy content of water to generate hot water or steam that in turn can be used for a number of applications. Many fossil and non-fossil fuels are fired in boilers, but the most common types of fuel include coal, oil, and natural gas.

Boilers are sometimes classified by their heat sources. For example, boilers are often referred to as oil-fired, gas-fired, coal-fired, or solid fuel-fired boilers. A variety of boilers, especially for the purpose of supplying domestic hot water, also use electricity as primary fuel.

This study focuses on oil-fired boilers and water heaters. As the name implies, the oil-fired boilers and water heating systems use liquid petroleum fuels that are stable at normal temperature and pressure. Such fuels include; crude oil and condensate used directly as fuel, refined products used as fuels (aviation gasoline, automotive gasoline, power kerosene, aviation turbine fuel, lighting kerosene, heating oil, automotive diesel oil, industrial diesel fuel, fuel oil, refinery fuel and naphtha). This report does not cover boilers and water heaters that use natural gas, LPG or other fuel types that can not be categorized as "oil" fuels, as primary fuel.

The oil-fired heating systems differ from natural gas and LPG fired boilers primarily on the basis of type of burner and fuel supply technique. The oil-fired boilers and water heating systems require storage tank and fuel feed systems that are generally not required in case of natural gas-fired boilers.

Like other types of boilers, the primary function of oil-fired boilers and water heating systems is also to generate hot water or steam. Therefore, unless mentioned otherwise the following paragraphs provide a generalized overview of boilers and water heating systems in general that also applies to oil-fired boilers and water heating systems.

Boilers are occasionally distinguished by their method of fabrication. Packaged boiler refers to a boiler that is shipped complete with heating equipment, mechanical draft equipment, and automatic controls; usually shipped in one or more sections. A packaged boiler includes factory-built boiler manufactured as a unit or system, disassembled for shipment, and reassembled at the site. Shop-assembled boilers are built up from a number of individual pieces or subassemblies. After these parts are aligned, connected, and tested, the entire unit is shipped to the site in one piece. Field-erected boilers are too large to transport as an entire assembly. They are constructed at the site from a series of individual components. Sometimes these components require special transportation and lifting considerations because of their size and weight.

For commercial and domestic applications, boilers can be classified as follows[2]:

- Those that generate low temperature hot water (<100oC) used for example in domestic central heating systems (also can be used for hot water);
- Those that produce high temperature hot water (>100oC, under pressure), used for example in food processing;
- And those that generate steam for use in industrial processes.

Domestic central heating boilers and water heating systems are generally in the size range of 4kW to 60kW for single residences and up to 350kW for multi-residential applications. Commercial units range from 50kW to 5MW.

For residential use there are three traditional groups of boiler, Free Standing, Wall Mounted & Back Boilers. There are two other general categories, referred to as Condensing Boilers and Combination Boilers (usually referred to as Combi's).

**Free standing** boilers are usually fairly 'slim' for fitting between kitchen units, although they may be installed in any suitable location. These boilers are available as Room Sealed, Fanned Flue or Conventional flue versions.

**Wall mounted** boilers have lighter, more compact heat exchangers, constructed from materials such as copper, aluminium, stainless steel or lightweight cast iron. These boilers are available as Room Sealed, or Fanned Flue versions. The Conventional Flue version of this boiler is no longer available. Most modern boilers of this type, are required to have a 'system by-pass' fitted to allow sufficient water to circulate through the appliance to prevent 'kettling' (the same kind of noise associated with a 'singing' kettle)

**Back boilers** are fitted into the opening behind a fireplace surround and are usually hidden behind a gas fire. A back boiler unit will save space elsewhere in the house, but its output is limited to 16kW (55,000 BTU/hr). The noise when operating can at times be intrusive and a ventilation path direct to outside must be maintained at all times.

**Condensing boilers** are not new, they have been around for many years and users, report very significant reductions in fuel costs, in some cases. This is possible, because this type of boiler has a much more effective 'heat exchanger' allowing more heat to be removed from the flue products. Typically, a condensing gas boiler might have a seasonal efficiency of around 88% compared to non-condensing boiler of about 75%, and an older type boiler at between 55% -60%.

[2] Analysis of Potential for Minimum Energy Performance Standards for Packaged Boilers; Final Report prepared for AGO by Mark Ellis & Associates, March 2001.

**Combination boilers** are popular in Europe, where wet central heating systems use a boiler to heat a copper cylinder in the airing cupboard to provide domestic hot water. A combination boiler (usually referred to as a'combi' ) provides a means of generating hot water for the taps from within the unit and combines this with central heating.

There is a wide range of boiler designs used for commercial and industrial applications. Some of the variable features include:

- Fuel type: commercial units are usually electric or gas fired and coal, gas, oil, sawdust and other waste fuels such as bagasse may be used in industrial boilers.
- Boilers may be located locally or remotely relative to the end user
- Manual or automatic control
- Water tube or fire tube, high/low fire or fully modulating
- Different number of passes depending on the application
- Have economisers and use condensate for feed.

Burner designs may be single jet, multiple jet, ring type, pilot flame, dual fuel, single pipe, two pipes. The pattern, length, swirl, number and homogeneity of flame can vary considerably and vary with air pollution limitations, and all of these factors affect efficiency and part load performance.

## *Boiler Efficiencies*

The efficiency of a boiler depends on:

- fuel
- boiler type and design
- whether the unit includes automatic or permanent pilot
- ignition (gas only)
- the type of burner control, i.e. on/off, gas modulating or air/gas modulating
- the load on the boiler due to the weather
- the sizing of the boiler and radiators relative to the design heat load
- the system controls
- flow and return temperatures
- installation and commissioning
- regular servicing and maintenance.

Considerable work has been carried out in recent years in order to produce some meaningful boiler efficiency figures. Domestic gas boilers have had their efficiencies

measured for many years but as the products have changed and the need for more helpful figures has been required the measurements have become more and more complex.

Over the last twenty years the efficiency tests, which have been used with domestic boilers, have changed many times so any comparison of figures old and new should be made very carefully. However, in general the efficiencies have improved over this period.

All boilers are more efficient when the temperature of the water entering them is low. This is particularly the case with condensing boilers where a return water temperature below about 54°C keeps it condensing, which is its very highest efficiency mode.

The type of appliance and the way it works determines the test method and the minimum requirement. Boilers with simple On/off thermostats are treated differently to ones which modulate their input and condensing boilers are tested at different temperatures to standard boilers.

Under most testing methods, the appliance is first tested at Full Load, that is at maximum output, and with flow and return temperatures in certain range e.g. 80°C and 60°C.

The second test is a Part Load test and is in a way an attempt to subject the boiler to what can happen in use. The load is set at certain loading condition, e.g. 30% maximum, and then the test is made with an average return water temperature depending on boiler type. This is a tricky test to do and has to be repeated several times and an average is then taken of the results.

## *Efficiency of Oil-fired boilers and water heating systems*

Very limited information is available on current operating efficiencies of oil-fired boilers and water heaters in Australia. In the absence of such information it was only reasonable to make estimates on the basis of data available elsewhere in the world.

In UK a seasonal efficiency database of boilers, called SEDBUK, was developed under Government's Energy Efficiency Best Practice Programme with the co-operation of boiler manufacturers, and provides basis for fair comparison of the energy performance of different boilers.

SEDBUK is the average annual efficiency achieved in typical domestic conditions, making reasonable assumptions about pattern of usage, climate, control, and other influences. It is calculated from the results of standard laboratory tests together with other important factors such as boiler type, ignition arrangement, internal store size, fuel used, and knowledge of the UK climate and typical domestic usage patterns.

The project took place over a period of three years, during which a theoretical seasonal efficiency model was developed for simple boilers and then adapted to include other types. Experimental data obtained from detailed laboratory tests on over 20 different boilers, supported by data from field trials in 99 homes, was used to validate the

theoretical assumptions. This allowed fuel usage data (termed "signature") to be related to efficiency test results supplied by manufacturers.

The SEDBUK data was used to estimate average operating efficiencies of domestic oil-fired boilers by age and capacity of the boilers. The analysis included 823 boilers of different makes, models, capacities and ages. Table 1 summarizes the results as average efficiency by age and capacity.

**Table 1: Efficiencies of domestic oil-fired boilers in UK**

| Capacity (kW) / Age (years) | Up to 15kW | >15 & ≤ 30 kW | >30 & ≤ 45 kW | >45 & < 60 kW | >60 & ≤ 75 kW | >75 kW | Average by age |
|---|---|---|---|---|---|---|---|
| **Up to 5 yrs** | 86.6 | 85.9 | 85.9 | 86.0 | 85.1 | 85.5 | **85.9** |
| **>5 & ≤10 yrs** | 84.0 | 83.9 | 84.6 | 85.2 | 84.6 | | **84.4** |
| **>10 & ≤20 yrs** | 84.2 | 85.7 | 86.0 | | | | **85.8** |
| **>20 yrs** | 66.9 | 67.6 | 74.6 | 77.9 | 83.2 | 85.7 | **73.3** |
| **Average by Capacity** | **77.5** | **81.5** | **83.2** | **83.9** | **84.4** | **85.6** | **82.5** |

It is worth noting that the average operating conditions in Europe/UK are much colder than those in Australia. As wether conditions affect the average operating efficiency of a boiler, this could mean that the operating efficiencies of boilers in Australia could be slightly different than those in Europe and UK. Nonetheless the efficiency values in Table 1 provide some ballpark estimates for boiler efficiencies in Australia.

# Australian Market Characteristics

## Domestic

Domestic boilers are generally the low temperature hot water type, being almost exclusively used in central space heating applications. Currently the annual market for domestic boilers is estimated at 6,000 units and the current stock is estimated at 90,000 units[3]. Please note that this estimate includes boilers using all types of fuel.

The annual market of domestic water heating systems, on the other hand, has been estimated at around 800,000 units with an estimated current stock of around 7.5 Million units.

There is limited information available on the shares of oil-fired boilers and water heating systems in operation or available from the market. However, an ABS study estimated the number of units installed in dwellings for the purpose of space and water heating, and cooking by fuel type[4]. The study provided the number of units for the years 1994, 1999 and 2002.

The study found that electricity and gas were the most preferred fuels for space and water heating, and cooking purposes. Table 2 summarizes key findings of the study.

**Table 2: Principal fuel types used in dwellings, number of dwellings ('000) by purpose**

| Fuel Type | Room Heating | | | Water Heating | | | Cooking[a] | |
|---|---|---|---|---|---|---|---|---|
| | 1994 | 1999 | 2002 | 1994 | 1999 | 2002 | 1999 | 2002 |
| Electricity | 1,906.4 | 1,997.3 | 2,309.2 | 3,999.3 | 4,253.8 | 4,588.0 | 4,181.1 | 4,270.0 |
| Gas | 2,044.3 | 2,349.6 | 2,555.0 | 2,153.8 | 2,526.7 | 2,810.1 | 2,887.0 | 3,169.1 |
| Wood | 1,130.4 | 1,118.3 | 1,024.2 | ** | 73.9 | 44.9 | 51.4 | 34.6 |
| Solar | 3.8 | *0.8 | *1.0 | 317.1 | 344.7 | 322.4 | - | - |
| Oil | 200.0 | 156.3 | 92.6 | ** | 2.2 | *1.9 | 0.9 | - |
| Coal/coke | ** | *2.7 | *1.3 | ** | - | *0.6 | - | - |
| Other | 90.6 | 44.5 | 31.6 | 141.9 | 12.4 | 15.3 | 14.8 | - |
| Don't know | ** | *7.5 | - | ** | 36.9 | 117.6 | - | - |
| None | 1,039.1 | 1,458.1 | 1,458.7 | - | - | - | - | - |
| Total | 6,414.5 | 7,135.2 | 7,473.7 | 6,612.1 | 7,250.6 | 7,473.7 | 7,135.2 | 7,473.7 |

a Not collected in 1994.
* Low statistical reliability
** Included in Other.

[3] Analysis of Potential for Minimum Energy Performance Standards for Packaged Boilers, Final Report, Prepared for the Australian Greenhouse Office by Mark Ellis & Associates, March 1st, 2001

[4] Environmental Issues: People's Views and Practices (ABS Publication #4602.0)

As can be seen that the number of oil-based heating and cooking systems have declined rapidly during the period between 1994 and 2002. The number of oil-based space heating systems dropped from 200,000 units in 1994 to less than 93,000 units in 2002, a decline of nearly 54% in 8 years. Similarly the number of oil-based water heating systems dropped from 2,200 units in 1999 to 1,900 units in 2002, a decline of about 14% in 3 years.

Assuming a similar trend would have followed the current numbers of oil-based space and water heating systems are estimated to be less than 80,000 units and 1,700 units respectively. It is worth noting that such estimate may also include units that are beyond the scope of this study. Figure 1 and Figure 2 graphically illustrate such declining trends for domestic space and water heating systems.

**Figure 1: Number of oil-fired domestic space heating systems 1994-2002**

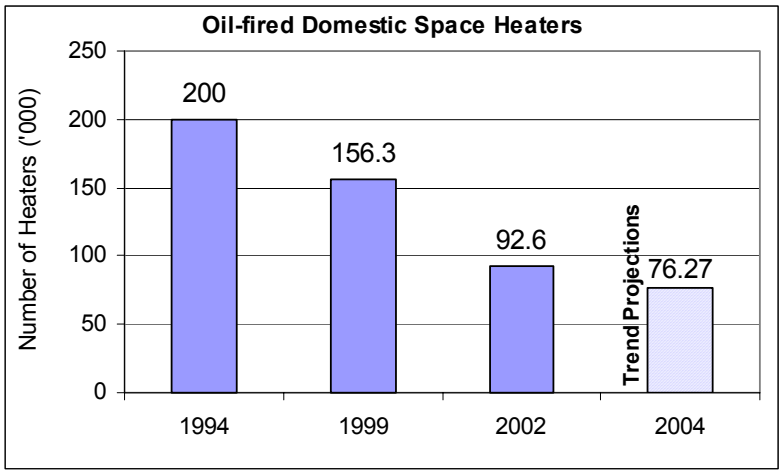
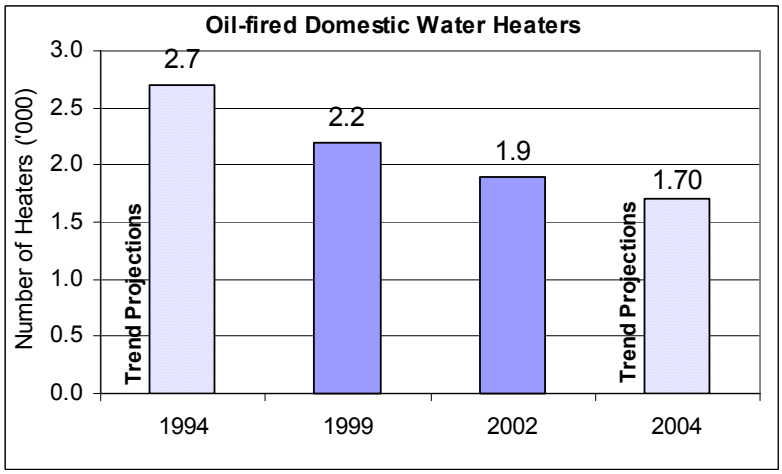



**Figure 2: Number of oil-fired domestic water heating systems 1999-2002**



Based on such data, the present stock shares of oil-fired space and water heating systems are estimated to be around 1.5% and 0.02% respectively.

The above estimates appear to be reasonably consistent with the estimates shared by leading manufacturers and distributors during phone interviews. These industry contacts believed that the share of domestic oil-fired boilers and water heating systems in the current stock was around 1%.

## *Commercial*

Similar to domestic market, very limited data is available on number, size and energy performance of oil-fired boilers and water heating systems used for commercial and industrial purposes. The industry sources contacted for this study suggested that the market for new oil-fired boilers and water heating systems was declining rapidly. According to such industry sources there is no assembly production for oil-fired systems and only a limited number of units are manufactured each year to serve a very small intermittent market. Some manufacturers and engineering firms mentioned their involvement in conversion of combustion systems of several oil-fired boilers to gas-fired systems during past several years. It was also reported that as a measure of security of energy supply, several primarily gas fired boilers are fitted with oil-firing alternatives.

The industry sources also provided some estimates that form basis for indicative shares of oil-fired systems for each state. It appears that remote areas of Queensland and Northern Territory are the major users of such appliances. It is estimated that 25% - 30% of industrial scale boilers in Queensland and NT are oil-fired. While it could not be verified, it is expected that a large number of such boilers are custom designed, field erected, large capacity boilers that are generally not regulated through MEPS.

All sources agreed that the number of commercial and industrial-scale oil-fired boilers and water heating systems was declining rapidly and if not at present, their share in total boiler and water heater market would be insignificant in few years. Such view is supported by the data provided by ABARE as shown in Table 3. The table shows breakdown of total energy used by commercial and industrial-scale boilers by fuel type for the period between 1974 and 1999. In the absence of credible data, projected estimates were calculated using simple trend analysis to present likely current situation. Only key fuel types are included to provide a comparative assessment.

It can be seen that the use of all fuel types that fall in the broader category of "oil" has consistently declined over the period between 1974 and 1999.

Table 4 provides a more detailed assessment of decline in oil as fuel for industrial and commercial boilers. It can be seen that the combined share of all "oil" fuels in 19974-75 was around 15%, which declined to a meagre 2.5% in 1998-99. The projected trend estimates suggest that the share of oil as primary boiler fuel would have declined to around 1% in the year 2004. Table 3 and Table 4 clearly show a diminishing market share of oil-fired boilers for commercial and industrial usage.

**Table 3: Trend of primary boiler fuel for industrial and commercial use (PJ)[5]**

| Fuel Type | 1974-75 | 1979-80 | 1984-85 | 1989-90 | 1994-95 | 1998-99 | 2003-04* |
|---|---|---|---|---|---|---|---|
| Black coal | 436.25 | 605.56 | 769.05 | 911.04 | 1022.23 | 1166.05 | 1312.51 |
| Brown coal | 245.05 | 291.86 | 350.66 | 434.53 | 479.27 | 638.56 | 660.78 |
| LPG | 0.11 | 0.35 | 0.62 | 1.3 | 1.61 | 1.8 | 2.23 |
| ADO | 3.23 | 4.55 | 5.31 | 3.78 | 3.37 | 3.53 | 3.62 |
| IDF | 12.46 | 7.95 | 1.42 | 0.4 | 0.37 | 0.3 | 0.00 |
| Fuel oil | 95.85 | 100.43 | 46.62 | 25.65 | 19.77 | 18.36 | 0.00 |
| Petroleum products nec | 38.62 | 34.58 | 27.56 | 30.44 | 36.65 | 31.2 | 30.43 |
| Natural gas | 76.32 | 135.24 | 219.26 | 263.97 | 279.3 | 227.79 | 323.62 |
| Electricity | | 0.34 | 0.33 | 0.74 | 0.86 | 1.01 | 1.21 |

* Projected estimates on the basis of trend analysis

**Table 4: Share of fuel type as percentage of total primary boiler fuel for industrial and commercial use**

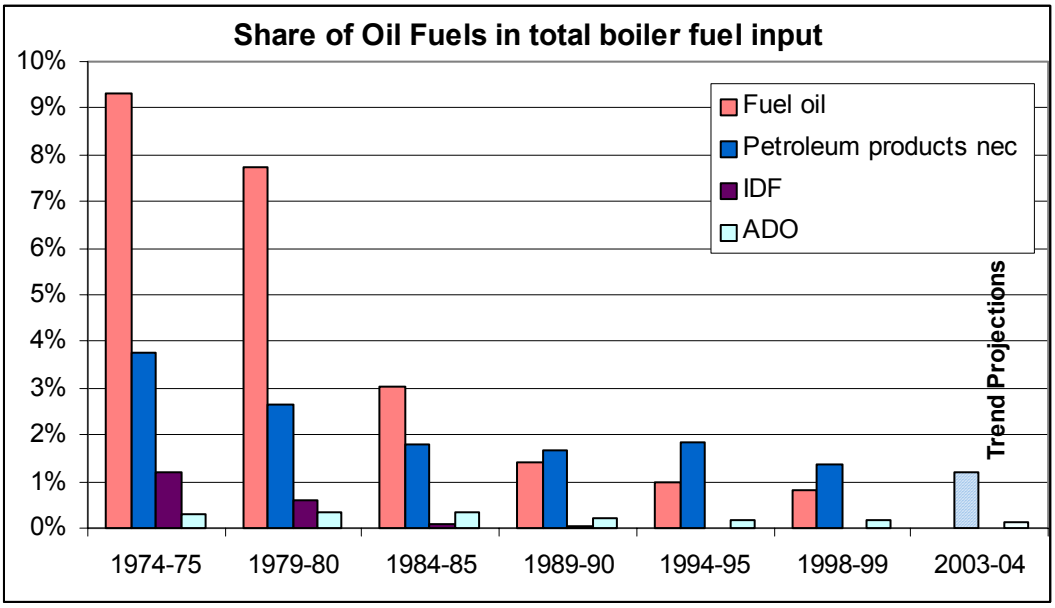
| Fuel Type | 1974-75 | 1979-80 | 1984-85 | 1989-90 | 1994-95 | 1998-99 | 2003-04* |
|---|---|---|---|---|---|---|---|
| Black coal | 42.50% | 46.63% | 49.92% | 50.41% | 51.32% | 51.78% | 52.49% |
| Brown coal | 23.87% | 22.47% | 22.76% | 24.04% | 24.06% | 28.36% | 26.43% |
| LPG | 0.01% | 0.03% | 0.04% | 0.07% | 0.08% | 0.08% | 0.09% |
| ADO | 0.31% | 0.35% | 0.34% | 0.21% | 0.17% | 0.16% | 0.14% |
| IDF | 1.21% | 0.61% | 0.09% | 0.02% | 0.02% | 0.01% | 0.00% |
| Fuel oil | 9.34% | 7.73% | 3.03% | 1.42% | 0.99% | 0.82% | 0.00% |
| Petroleum products nec | 3.76% | 2.66% | 1.79% | 1.68% | 1.84% | 1.39% | 1.22% |
| Natural gas | 7.43% | 10.41% | 14.23% | 14.61% | 14.02% | 10.12% | 12.94% |
| Electricity | - | 0.03% | 0.02% | 0.04% | 0.04% | 0.04% | 0.05% |

* Projected estimates on the basis of trend analysis

Figure 3 graphically illustrates such diminishing trend for use of oil fuels as primary boiler fuel.

[5] ABARE Economics; http://www.abare.gov.au/freepdf/table%20c1.xls

**Figure 3: Trend of share of oil fuel in total boiler input fuel**



# *Relevant National Standards*

Australian Standards report the following standards that apply to the type of boilers and water heating systems covered in this report.

**AS2593: 1995 Boilers. Unattended and limited attendance, followed by Amendment No. 1: 1998:** This Standard specifies requirements for the design and manufacture boilers which are intended to be operated to produce steam or hot water for periods without human supervision. It includes special features within the control, management and supervision systems, associated valves and fittings, housing and installation, as well as, requirements and responsibilities for checking, testing and maintenance of these boilers. This standard contains no energy performance requirements or test method.

The Standard covers all types of fuel firing, these are as follows:

• Gaseous fuels.

• Oil fuel with closed flashpoint greater than 23°C.

• Solid fuels, including solid-fuel-in-suspension.

• Waste heat fluids.

• Electric power.

Status: Published in 5 July 1995, Amendment 1, 5 March 1998. It is currently being redrafted by the Standards Australia/New Zealand Standard Committee ME/1, Pressure Equipment, to cover the changes within the pressure equipment industry regarding the introduction of self regulation.

**AS 1690-1975: Rules for the safe design, construction and performance of domestic oil-fired appliances (known as the SAA Domestic Oil-fired Appliances Safe Design Code):** This standard applies to the safe design, construction and performance of fixed and flued domestic-type oil burning appliances of all types irrespective of the function of the appliance or the type of burner, but not normally over 60 kW energy input rate. This Code does not deal with flue-less or portable appliances, nor with the installation of the appliances. It deals with the appliance only as a manufactured item and does not cover any matters of installation (see AS 1691).This standard supersedes DR 74009 Rules for safe design, construction and performance of domestic oil-fired appliances.

Testing: The Code includes such test methods as may be necessary to identify those appliances that comply with this Code.

Status: As of 30th September 2004 this standard was current.

**AS 1691-1985 : Domestic oil-fired appliances - Installation :** This standard sets out requirements for the installation of fixed and flued domestic-type oil-burning appliances of up to 60 kW thermal input rate, together with their associated oil fuel supply systems, in domestic buildings, and in other buildings. It does not apply to the design and construction of appliances, rules for which are given in AS 1690. This standard contains no energy performance requirements or test method.

The recommendations on water heater installation details not covered by this standard, including plumbing, are covered in AS 1529.

Status: As of 30th September 2004 this standard was current.

**AS 2078-1977 : Domestic oil-fired appliances (quality and performance) :** This standard sets out the minimum acceptable levels of quality in the design, construction and performance of fixed and flued domestic oil burning appliances of all types, irrespective of their function or the type of their burners, and not normally over 60 kW energy input rate. Related methods of test are given. This standard supersedes DR 76095 Domestic oil-fired appliances (quality and performance).

Status: As of 30th September 2004 this standard was current.

# Review of International Approaches

This section reviews international practices related with specific energy efficiency requirements for oil-fired boilers and water heating systems. Various types of boilers are subjected to performance regulation in the European Union, Canada, the US and Chinese Taipei.

It is worth noting that the efficiency of a boiler is generally associated with loading conditions, and the average weather conditions in North America and Europe are significantly colder than most parts of Australia and therefore heating loads are much higher.

## MEPS

Three APEC countries, USA, Canada and Chinese Taipei, currently enforce MEPS specific to the energy performance of oil-fired boilers and water heaters. In 1992-93 the EU introduced the European Directive on Boiler Efficiency. This directive sets out standards for minimum energy efficiency values for all types of boilers in European Union. In UK a joint government and manufacturer initiative maintains a database of average operating efficiencies of all types of boilers manufactured and imported in the country.

## Canada

The Canadian economy is the eighth largest in the world (measured in US dollars at market exchange rates) after the US, Japan, Germany, the UK, France, China and Italy. It is highly integrated with the US economy, which absorbs over 85% of its exports. The Energy Efficiency Act passed in 1992 provides for the making and enforcement of regulations concerning minimum energy performance standards (MEPS) for energy-using products, as well as the labelling of energy-using products and the collection of data.

The following minimum energy performance standards apply to boilers and furnaces in Canada.

**CAN/CSA-B 212-00 Energy Utilization Efficiencies of Oil-Fired Furnaces and Boilers.** Historically CAN/CSA-B212-M93: Seasonal Energy Utilization Efficiencies of Oil-Fired Furnaces and Boilers**.** Published on October 1, 2000 by Canadian Standards Association.

This Standard specifies the methods for determining seasonal energy utilization efficiency (SEUE) and annual fuel utilization efficiency (AFUE) for

(a) oil-fired furnaces having an input of up to and including 66 kW (225 000 Btu/h); and

(b) boilers having an input of up to and including 88 kW (300 000 Btu/h). The tests contained in this Standard are not intended to represent actual efficiencies realized in the field. These tests provide a standardized method of comparing relative unit performance.

This Standard establishes minimum efficiency levels for oil-fired furnaces and boilers. This Standard applies to the oil-fired portion of a combination or multifuel burning appliance.

The applicable MEPS for different types of oil-fired appliances are described as follows.

a. The following mandatory requirement applies to oil-fired water heaters that have an input rating of not more than 30.5 kilowatts (0.75 U.S. gallons per hour) and storage capacity of not more than 190 litres (50 U.S. gallons). The minimum efficiency value is calculated as;

   **Allowable minimum EF for Input rating of not more than 30.5 kW (0.75 U.S. gallons per hour) = 0.59 - 0.0005V**

   Where;

   EF = Energy factor calculated as a dimensionless quantity;

   V = Volume of storage tank in litres

b. The following mandatory requirement applies to oil-fired boilers that are intended for use in a low-pressure steam or hot water central heating system and have an input rate of less than or equal to 88 kilowatts (300 000 Btu/h). The allowable minimum efficiency value is **SEUE 80%**.

   Where SEUE = Seasonal energy utilization efficiency

c. The following amendment related with energy efficiency of oil-fired water heaters is under consideration;

   Proposed Maximum Standby Loss or Minimum Energy Factor (EF) for Oil-fired Storage Water Heaters = EF greater than or equal to 0.59 - 0.0005V

   Where; V = rated storage capacity in litres.

## *United States*

The energy performance of commercial level oil-fired boilers and water heating systems in the USA is regulated through **ANSI/ASHRAE/IESNA Standard 90.1-2001, Energy Standard for Buildings Except Low-Rise Residential Buildings**. The standard covers the energy efficiency aspects of;

- Building Envelope,

- Heating, Ventilating, and Air-Conditioning,
- Service Water Heating,
- Power,
- Lighting, and
- Other Equipment

The applicable minimum efficiency requirements are shown in Table 5 below.

**Table 5: Gas- and oil-fired boilers–minimum efficiency requirements for buildings except low-rise residential buildings, USA**

| Equipment Type[a] | Size Category (Input) | Subcategory or Rating Condition | Minimum Efficiency[b] | Test Procedure |
|---|---|---|---|---|
| Boilers, Gas-Fired | <88 kW | Hot Water | 80% AFUE | DOE 10 CFR Part 430[d] |
| | | Steam | 75% AFUE | |
| | ≥88 kW and ≤733 kW | Maximum Capacity[c] | 75% $E_t$[b] | H.I. Htg Boiler Std.[e] |
| | >733 kW[a] | Hot Water | 80% $E_c$ | |
| | >733 kW[a] | Steam | 80% $E_c$ | |
| Boilers, Oil-Fired | <88 kW | | 80% AFUE | DOE 10 CFR Part 430 [d] |
| | ≥88 kW and ≤733 kW | Maximum Capacity[c] | 78% $E_t$ | H.I. Htg Boiler Std.[e] |
| | >733 kW[a] | Hot Water | 83% $E_c$ | |
| | >733 kW[a] | Steam | 83% $E_c$ | |
| Oil-Fired (Residual) | ≥88 kW and ≤733 kW | Maximum Capacity[c] | 78% $E_t$[b] | H.I. Htg Boiler Std.[e] |
| | >733 kW[a] | Hot Water | 83% $E_c$ | |
| | >733 kW[a] | Steam | 83% $E_c$ | |

a. These requirements apply to boilers with rated input of 2346 kW or less that are not packaged boilers, and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.
b. $E_t$ = thermal efficiency.
c. Minimum and maximum ratings as provided for and allowed by the unit's controls
d. Uniform Test Method for Measuring the Energy Consumption of Furnaces
e. Hydronics Institute's Testing and Rating Standard for Heating Boilers

Table 6 shows minimum efficiency requirements for domestic water heaters in the US. Table 7 presents minimum energy performance standards for domestic scale boilers and furnaces in the US.

**Table 6: Minimum energy performance requirements for domestic water heaters in the US**

| Product class | Energy factor as of January 1, 1990 | Energy factor as of April 15, 1991 | Energy factor as of January 20, 2005 |
|---|---|---|---|
| 1. Gas-fired Water Heater | 0.62 - (0.0019 × Rated Storage Volume in gallons) | 0.62 - (0.0019 × Rated Storage Volume in gallons) | 0.67 - (0.0019 × Rated Storage Volume in gallons) |
| 2. Oil-fired Water Heater | 0.59 - (0.0019 × Rated Storage Volume in gallons) | 0.59 - (0.0019 × rated Storage Volume in gallons) | 0.59 - (0.0019 × Rated Storage Volume in gallons) |
| 3. Electric Water Heater | 0.95 - (0.00132 × Rated Storage Volume in gallons) | 0.93 - (0.00132 × Rated Storage Volume in gallons | 0.97 - (0.00132 × Rated Storage Volume in gallons) |
| 4. Tabletop Water Heater | 0.95 - (0.00132 × Rated Storage Volume in gallons) | 0.93 - (0.00132 × Rated Storage Volume in gallons) | 0.93 - (0.00132 × Rated Storage Volume in gallons) |
| 5. Instantaneous Gas-fire Water Heater | 0.62 - (0.0019 × Rated Storage Volume in gallons) | 0.62 - (0.0019 × Rated Storage Volume in gallons) | 0.62 - (0.0019 × Rated Storage Volume in gallons) |
| 6. Instantaneous Electric Water Heater | 0.95 - (0.00132 × Rated Storage Volume in gallons) | 0.93 - (0.00132 × Rated Storage Volume in gallons) | 0.93 - (0.00132 × Rated Storage Volume in gallons) |

Note: The Rated Storage Volume equals the water storage capacity of a water heater, in gallons, as specified by the manufacturer.

**Table 7: Minimum energy performance requirements for domestic boilers and furnaces in the US[6]**

| Product class | AFUE[1] (percent) | Effective date |
|---|---|---|
| 1. Furnaces (excluding classes noted below) (percent) | 78 | 01/01/92 |
| 2. Mobile Home Furnaces (percent) | 75 | 09/01/90 |
| 3. Small furnaces (other than furnaces designed solely for installation in mobile homes) having an input rate of less than 45,000 Btu/hr | | |
| (A) Weatherized (outdoor) | 78 | 01/01/92 |
| (B) Non-weatherized (indoor) | 78 | 01/01/92 |
| 4. Boilers (excluding gas steam) (percent) | 80 | 01/01/92 |
| 5. Gas steam boilers (percent) | 75 | 01/01/92 |
| (A) Weatherized (outdoor) | 78 | 01/01/92 |
| (B) Non-weatherized (indoor) | 78 | 01/01/92 |

1 Annual Fuel Utilisation Efficiency

## *Europe and UK*

In 1992 the Council of European Union passed a directive that tends to regulate energy performance of boilers in all member countries of the Union. Article 5 of the COUNCIL

[6] Analysis of Potential for Minimum Energy Performance Standards for Packaged Boilers, Final Report, Prepared for the Australian Greenhouse Office by Mark Ellis & Associates, March 1st, 2001

DIRECTIVE 92/42/EEC of 21 May 1992 on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels provides that;

Boilers must comply with the following useful efficiency requirements:

1. at rated output, i.e. operating at rated output Pn expressed in kW, at an average boiler-water temperature of 70 ºC , and

2. a part load, i.e. operating at 30 % part load, at an average boiler water temperature which varies according to the type of the boiler.

The useful efficiency requirements to be complied with are set out in Table 8. A copy of the directive is attached as **Appendix B:** Product standards; Efficiency requirements for hot-water boilers - Guidance notes on UK Regulations, October 1995.

**Table 8: Useful efficiency requirements for boilers in European Union**

| Type of boiler | Range of power output | Efficiency at rated output | | Efficiency at partload | |
|---|---|---|---|---|---|
| | kW | Average boiler water temperature (in ºC) | Efficiency requirement expressed (in %) | Average boiler water temperature (in ºC) | Efficiency requirement expressed (in %) |
| Standard boilers | 4 to 400 | 70 | ≥ 84 + 2 logPn | ≥ 50 | ≥ 80 + 3 logPn |
| Low-temperature boilers* | 4 to 400 | 70 | ≥ 87,5 + 1,5 logPn | 40 | ≥ 87,5 + 1,5 logPn |
| Gas condensing boilers | 4 to 400 | 70 | ≥ 91 + 1 logPn | 30** | ≥ 97 + 1 logPn |

(*) Including condensing boilers using liquid fuels.
(**) Temperature of boiler water-supply.

The directive requires member states to implement the directive efficiency standards through appropriate legislative tools. UK legally incorporated the directive through "The Boiler (Efficiency) Regulations 1993 (SI 1993/3083)" that entered into force on 1 January 1994 for those requirements relating to boiler efficiency and from and 1 January 1995 for those requirements relating to the amended criteria for CE marking. A copy of the relevant document produced by Department of Trade and Industry UK is attached as **Appendix B:** Product standards; Efficiency requirements for hot-water boilers - Guidance notes on UK Regulations, October 1995.

Concurrent to EU Directive on boiler efficiency, in UK a seasonal efficiency database of boilers, called SEDBUK, was developed under Government's Energy Efficiency Best Practice Programme with the co-operation of boiler manufacturers, and provides a basis for fair comparison of the energy performance of different boilers.

SEDBUK is the average annual efficiency achieved in typical domestic conditions, making reasonable assumptions about pattern of usage, climate, control, and other

influences. It is calculated from the results of standard laboratory tests together with other important factors such as boiler type, ignition arrangement, internal store size, fuel used, and knowledge of the UK climate and typical domestic usage patterns.

The project took place over a period of three years, during which a theoretical seasonal efficiency model was developed for simple boilers and then adapted to include other types. Experimental data obtained from detailed laboratory tests on over 20 different boilers, supported by data from field trials in 99 homes, was used to validate the theoretical assumptions. This allowed fuel usage data (termed "signature") to be related to efficiency test results supplied by manufacturers.

As a simple guide to efficiency, a scheme has been created with SEDBUK efficiency bands assigned to boilers on an "A" to "G" scale. The band is shown in the database and may be used on product literature and labels, though there is no requirement for manufacturers to do so. The key purpose of the scheme is to make an informed decision when choosing a new boiler or estimating the average boiler costs for different makes and models available in UK. Figure 4 shows these bands corresponding to efficiency ranges.

**Figure 4: SEDBUK boiler energy efficiency bands**

| | |
|---|---|
| A | 90% and above |
| B | 86% - 90% |
| C | 82% - 86% |
| D | 78% - 82% |
| E | 74% - 78% |
| F | 70% - 74% |
| G | below 70% |

## *Chinese Taipei (Taiwan)*

On July 1st 2003, the Taiwanese Ministry of Economic Affairs fully implemented mandatory MEPS for oil-fired boilers. The Efficiency Standard is applicable to steam boilers with oil or gas firing, but not for through-flow boilers. Energy Efficiencies are calculated with Heat Loss Method by low heating value, which if regulated by CNS 2141. The boiler is under full load and waste heat recovery systems should be included if have. Table 9 shows minimum energy efficiency requirements for oil-fired boilers by capacity and boiler type.

**Table 9: Minimum energy efficiency requirements for oil-fired boilers in Taiwan**

| Fuel Type<br>Black coal | Minimum Efficiency Requirement by Capacity (ton/hr) | | | |
|---|---|---|---|---|
| | **< 5** | **> 5 and < 10** | **> 10 and < 30** | **> 30** |
| Water-Tube Oil Firing Boiler | 88.50% | 89.50% | 91.00% | 92.50% |
| Water-Tube Gas Firing Boiler | 90.50% | 91.50% | 92.50% | 93.50% |
| Smoke-Tube Oil Firing Boiler | 87.00% | 88.00% | 89.00% | 90.00% |
| Smoke-Tube Gas Firing Boiler | 89.0% | 90.0% | 91.0% | 92.0% |
| Water-Tube Oil Firing Boiler | 88.50% | 89.50% | 91.00% | 92.50% |

## *Japan*

Japan does not have MEPS; instead it operates the Top Runner standards program. This program aims to dramatically improve energy efficiency of appliances by setting target values based on the current highest efficiency level of each type of product instead of the current average efficiency level. Manufacturers and importers have to ensure the average (sales weighted) efficiency of all their appliances meet this standard by a specified date (the target year). The program allows a continuum for improvement over time making manufacturers constantly increase the efficiency of appliances. The Top Runner standards are voluntary as there is no minimum level, however penalties can be evoked if the average efficiency target is not met. The Ministry of Economy Trade and Industry monitor the program and it is legislated through the Energy Conservation Law. The program so far has been quite successful with most manufacturers gearing up to meet the targets. When the target year is reached, new target levels can be established.

Top Runner Programs for Oil-fired Water and Space Heaters have been developed and are expected to be fully implemented by 2006. In the meanwhile, an existing voluntary labelling program allows for identification of efficient products in the market.

Japan's new label allows consumers to ascertain how an appliance fairs in relation to the Top Runner Standard (see MEPS). Firstly the labels are colour coded; yellow to indicate the models that are below (failed to meet) the efficiency target level and green for those above (i.e. better than) the efficiency target level. Secondly, the label displays the ratio percentage of the standard that the model has achieved, i.e. if it operates at the Top Runner standard level then the ratio is 100%. Thirdly the label displays the annual energy consumption of the appliance and also the year by which the target is to be attained. The Energy Efficiency Policy Division of the Agency of Natural Resources and Energy, which sits within the Ministry of Economy Trade and Industry, administer the program. The labels are to be adhered to the appliance as well as packaging and in advertising.

Details of two top runner programs are provided as follows.

## Top Runner Program for Oil-fired Water Heaters

Scope:

- Water heaters for home that use oil as their fuel.
- Baths with pot-type burners, water heaters for commercial use, wood-burning water heaters, and water heaters with gauge pressure exceeding 0.1 MP are excluded.

Energy Consumption Efficiency:

- The heat efficiency (%) measured in the manner specified by JIS.

The target efficiency values are shown in Table 10.

**Table 10: Category target values for Top Runner Program for oil-fired water heaters**

| Category | | | | Standard energy consumption efficiency |
|---|---|---|---|---|
| **Purpose** | **Heating Type** | **Air supply & exhaust type or control method** | **Category** | |
| For hot water supply | Instantaneous type | | A | 86.0 |
| | Storage type with rapid heating system | | B | 87.0 |
| | Storage types other than rapid heating system | | c | 85 |
| For heaters | Instantaneous type | Unvented type | D | 85.3 |
| | Storage type with rapid heating system | Vented type | E | 79.4 |
| | | Direct vent type | F | 82.1 |
| | Instantaneous type | On/off control | G | 87.0 |
| | | Other than on/off control | H | 82.0 |
| | Storage type with rapid heating system | | I | 84.0 |
| For baths | | Water heaters with centre fuel heat exchanger | J | 75.0 |
| | | Water heaters without centre fuel heat exchanger | K | 61.0 |

Energy conservation effects:

- Approximately 3.5% improvement in efficiency compared to 2000 levels by 2006.

Display items:

- Product name and type; category; energy consumption efficiency; manufacturer's name

Place of display:

- Product body and catalogues in which data on performance is shown.

Exemption:

- Manufacturers or importers who ship less than 600 units in total are excluded, but display obligations must be met regardless of the number of units shipped.

## Top Runner Program for Oil-fired Space Heaters

Scope:

- Restricted to those using gas or oil as fuel.
- Unvented types, space heaters using gases other than those in the group of city gas 13A and liquefied petroleum gas as fuel, vented gas space heaters, vented oil space heaters with a maximum fuel consumption of over 4.0l/h, and direct vent type oil space heater with a maximum fuel consumption of over 2.75l/h are excluded. Energy Consumption Efficiency:

Energy Consumption Efficiency:

- The heat efficiency (%) measured in the manner stipulated by JIS.

The target efficiency values are shown in Table 11.

**Table 11: Category target values for Top Runner Program for oil-fired boilers**

| Category | | | Standard energy consumption efficiency |
|---|---|---|---|
| **Air supply and exhaust type** | **Heating transfer type** | **Category name** | |
| Direct vent type | Natural convection type | A | 83.5 |
| | Forced convection type | B | 86.0 |
| Vented type | Radiating type | C | 69.0 |
| | Other than radiating type with maximum fuel consumption of 1.5 litres per hour or less | D | 67.0 |
| | Other than radiating type with maximum fuel consumption of more than 1.5 litres per hour or less | E | E = -3.0L + 71.5 |

Remarks: E and L. shall express the following numeric values;
E: Standard energy consumption efficiency (unit: percent)
L: Maximum fuel consumption (unit litres per hour)

Energy conservation effects:

- Approximately 1.4% for gas space heaters and approximately 3.8% for oil space heaters improvement in efficiency compared to 2000 levels by 2006.

Display items:

- Product name or type; category (restricted to oil space heaters); maximum fuel consumption (restricted to non-radiation types among vented type oil space heaters whose maximum fuel consumption is over 1.5l/h); energy consumption efficiency; manufacturer's name

Place of display:

- Product body and catalogues in which data on performance is shown.

Exemption:

- Manufacturers or importers who ship fewer than 300 units in total are excluded, but display obligations must be met regardless of the number of units shipped.

# Testing Standard

## Canada

CAN/CSA-B 211-00; Energy Efficiency of Oil-Fired Storage Tank Water Heaters, December 1, 2000

Scope:

- This Standard specifies the method for determining the energy factor for oil-fired storage tank water heaters.

- This Standard establishes minimum energy efficiency levels for oil-fired storage tank water heaters.

- This Standard applies to oil-fired storage tank water heaters with an input rating of 107 000 kJ/hr or 30.5 kW (0.75 USGPH) or less and a manufacturer's specified storage capacity of 190 L (50 US gal) or less.

- The tests contained in the Standard are not intended to represent actual efficiencies realized in the field. Instead, these tests provide a standardized method of comparing relative unit performance.

- This Standard is written in SI units. The values in parentheses are for information only. The SI values have been calculated from the US Customary Units found in the US Code of Federal Regulations, Department of Energy publication, Title 10, Part 430, Subpart B, Appendix E.

## United States

Currently in the US the boiler efficiency is determined by tests developed by Hydronics Institute's Testing and Rating Standard for Heating Boilers, H.I. Htg Boiler Std. However, more recently Department of Energy (DOE) required by Energy Policy and Conservation Act and its amendments to consider national energy conservation standards for residential furnaces and boilers, has proposed a number of minimum energy performance requirements and testing standards for domestic boilers and furnaces.

- 10 CFR Part 431 Energy Efficiency Program for Certain Commercial and Industrial Equipment: Test Procedures and Efficiency Standards for Commercial Packaged Boilers

  Status: Notice of proposed rulemaking and public hearing.

- 10 CFR Part 431 Energy Efficiency Program for Certain Commercial and Industrial Equipment: Test Procedures and Efficiency Standards for Commercial Water Heaters, Hot Water Supply Boilers and Unfired Hot Water Storage Tanks

  Status: Notice of proposed rulemaking and public hearing.

- 10 CFR Part 430 Energy Conservation Program for Consumer Products: Test Procedures for Furnaces/Boilers, Vented Home Heating Equipment, and Pool Heaters

  Status: Final rule.

- 10 CFR Part 430 Energy Conservation Program for Consumer Products: Test Procedure for Water Heaters

  Status: Final rule

## Europe and UK

Article 5 (2) of the Council Directive 92/42/EEC of 21 May 1992, states that "The harmonized standards relating to the requirements of this Directive drawn up under mandate from the Commission in accordance with Directive 83/189/EEC and 88/182/EEC (1) shall determine, inter alia, the verification methods valid for production and measurements".

In UK, under the Government's Standard Assessment Procedure (SAP), a detailed method for measuring the efficiency and conformity of a boiler to Council Directive 92/42/EEC of 21 May 1992 is provided. This method is applicable to domestic boilers and the details of the method are attached as Appendix C. More recently Fabermaunsell, under the Department of Transport's (DTI) Partners in Innovation Project 39/3/720, has produced 'Rating Scales for Seasonal Efficiency of Boilers and Chillers'. This document does not provide detailed method for measuring the energy efficiency or conformity to

EU Directive for Boilers. However, it provides guidelines to estimate seasonal efficiencies on the basis of laboratory tested efficiencies at various loads. The document is attached as Appendix D.

## Chinese Taipei (Taiwan)

In Taiwan the energy efficiency and conformity of a boiler to minimum efficiency requirements is assessed using testing standard CNS 2141.

## Japan

The heat efficiency is measured in the manner stipulated by JIS.

# Preliminary Views of Stakeholders

Table 12 lists stakeholders that were contacted over the phone to gather information and seek stakeholders' views on introduction of MEPS for oil-fired boilers and water heating systems in line with international practices.

**Table 12: List of stakeholders contacted**

| Company | Industry Position |
|---|---|
| Rayson Industries Pty Ltd | Riello gas and oil burners |
| Stokes Australasia Ltd | Manufacture electric heating systems |
| Hurlcon Pty Ltd | Heating boilers, hot water boilers and storage tanks |
| Forbes Boilers (NSW) | Boiler manufacturer |
| Forbes Boilers (Victoria) | Boiler manufacturer |
| John Thompson Package Boilers | Boiler manufacturer |
| Maxitherm Boilers Pty Ltd | Boiler manufacturer |
| Tomlinson Boilers Pty Ltd (Victoria) | Boiler manufacturer |
| Tomlinson Boilers Pty Ltd (Queensland) | Boiler manufacturer |

One of the key stakeholders, Boilers and Pressure Vessels Manufacturing Association of Australia (BPVMAA) could not be contacted. Their officially listed contact revealed that the association had moved from the listed location and the new whereabouts were unknown.

Not a great deal of specific information about oil-fired boilers and water heating systems could be gathered from the stakeholders. The stakeholders attributed this to presently very small share of these products. However, the manufacturers who have been involved in the production of oil-fired boilers in recent terms suggested that it was very unlikely that the efficiency of any new oil-fired boiler would be significantly less than its equivalent gas fired boiler.

It was a common view of the industry stakeholders that since the oil-fired boilers held very little share in the total boiler market and their number was declining very rapidly, introduction of MEPS would not result in any meaningful or significant amount of GHG reduction.

# Recommended MEPS levels

Based on the findings presented in Australian Market Characteristics and Preliminary Views of Stakeholders, no MEPS are recommended for domestic oil-fired boilers and water heating systems.

However, the Australian Building Codes Board is planning to introduce efficiency measures for many types of buildings, including office buildings. The current proposal for multi-residential buildings includes efficiency measures for oil-fired boilers and it is understood that these requirements will also apply to new office buildings when the draft regulation is released in late 2004. These efficiency requirements are consistent with equivalent requirements implemented in USA and UK.

# Impact of MEPS

The oil fuels contributed only 53.4PJ of total energy input of 2,252PJ to boilers for commercial and industrial use in the year 1998-99. This amounted to just 2.4% of the total boiler input energy in that year. At present the oil fuels are estimated to contribute only around 1% (34PJ) of the total fuel input to the industrial/commercial scale boilers.

The current oil fuel consumption by domestic boilers and water heating systems is estimated using the following assumptions[7];

- Average capacity of domestic boilers = 14kW
- Estimated annual number of hours of operation = 30 days x 3 months x 8 hours a day

Applying the above figures to the estimated number of oil-fired domestic boilers and water heaters operating at present, as shown in Figure 1 and Figure 2, the total annual energy consumption of this class of boilers and water heating systems is estimated to be 3.64PJ.

The potential efficiency improvements can be estimated by a combined analysis of;

- SEDBUK efficiency data as shown in Table 1,
- the applicable MEPS in Canada, Taiwan, USA and, Europe and UK, and,
- proposed target efficiency values for proposed two top runner programs in Japan as shown in Table 10and Table 11.

We believe that efficiency improvements in the range of 3% and 5% are achievable for all new commercial and industrial scale appliances. Larger scale efficiency improvements, around 5% to 10%, are possible for domestic appliance.

Assuming an ideal 100% replacement of present stock of domestic boilers and water heating systems would achieve a meagre 0.27PJ of annual fuel savings or a reduction of around 20kt $CO_2$-e[8] per year. On the hand a 100% replacement of present commercial and industrial scale stock with around 4% more efficient stock is estimated to result in a GHG reduction of around 127kt $CO_2$-e.

Note that the above estimates of GHG reduction are based on very optimistic assumptions e.g. 100% replacement. It is also important to note that the above estimates

[7] Analysis of Potential for Minimum Energy Performance Standards for Packaged Boilers, Final Report, Prepared for the Australian Greenhouse Office by Mark Ellis & Associates, March 1st, 2001

[8] Applying the relevant emission factors as provided in AGO Factors and Methods Workbook, August 2004

include a large share of significantly large industrial boilers that are often custom built and are generally not regulated by MEPS. Consequently the actual impact is likely to be far less than the above estimates, especially when there is a strong evidence of rapidly declining market.

Implementation of any level of MEPS for domestic appliances is very unlikely to achieve any significant level of impacts. On the other hand the efficiency improvement of commercial and industrial scale appliances offer some level of emission reduction potential. However, evidence suggests that such potential is unlikely to realize over coming years because of the rapidly diminishing market and small share of boilers that can be regulated under MEPS.

# Recommendations

Considering the rapidly diminishing market of oil-fired boilers and water heating systems for domestic use in Australia and due to a very marginal impact resulting from implementation of a suitable MEPS, it is recommended that no MEPS are introduced to this category of appliances at this stage.

The larger industrial and commercial level appliances offer higher level of impacts and hence demand more serious attention. Unfortunately because of the limitations associated with the availability of relevant information, it is not possible to establish actual current market situation. For example it is very likely that large industrial boilers account for a large share of total boiler oil fuel input of 53.4PJ. Because these boilers are custom designed, e.g. for power generation, they are normally not regulated by MEPS.

However, it is very obvious that the number of oil-fired boilers for industrial and commercial use, which can be regulated under MEPS, is also declining very rapidly.

It is proposed not to further consider including this product type in the program because of a number of related factors:

- the rapidly diminishing market of oil-fired boilers and water heating systems in Australia
- the relatively minor contribution to total energy use by oil-fired boilers
- the range efficiency levels of new oil-fired boiler is likely to be small
- the very marginal impact resulting from implementation of a suitable MEPS

# *References*

ABARE - Australian Bureau of Agriculture and Resource Economics

ABS – Australian Bureau of Statistics

ANSI - American National Standards Institute

APEC – ESIS (Energy Standards Information System)

AS – Australian Standards

BED - Boiler Efficiency Database, UK

BRE - Building Research Establishment UK

BSMI - Bureau of Standards, Metrology and Inspection, Taiwan

CSA – Canadian Standards Association

ECCJ - Energy Conservation Centre Japan

EERE – US Department of Energy Efficiency and Renewable Energy

EST – Energy Saving Trust, UK

OEE - Office of Energy Efficiency, Natural Resources Canada.

SEDBUK – Seasonal Efficiency of Domestic Boilers, UK

# ***Appendix A:*** *European Union Directive on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels*

# ***Appendix B:*** *Product standards; Efficiency requirements for hot-water boilers - Guidance notes on UK Regulations, October 1995*

# ***Appendix C:*** *The (UK) Government's Standard Assessment Procedure (SAP) for Energy Rating of Dwellings, 2001 Method of determining seasonal efficiency values for gas and oil boilers*

# ***Appendix D:*** *Rating Scales for Seasonal Efficiency of Boilers and Chillers (UK)*